tions of the symbol D, which, for the sake of simplicity, is written in place of $\frac{d}{dt}$. This the author calls the exponential form of the equation; and he, in like manner, designates the analogous forms of partial and of simultaneous equations. What he conceives to be the great and peculiar advantage of the exponential form, both as respects the solution of linear differential equations, and the theory of generating functions, is that the necessary developments, transformations and reductions are immediately effected by theorems the expression of which is independent of the forms of the functions $f_0(D), f_1(D)$, &c. Accordingly it may be shown that various formulæ which have been given for the solution of linear differential equations, with those in which Laplace's theory of generating functions is comprised, interpreted into the language of the author, are but special cases of theorems dependent on the exponential form above stated, and which are susceptible of universal application.

The common method of effecting the integration of linear differential equations in series fails when the equation determining the lowest index of the development has equal or imaginary roots. In a particular class of such equations of the second order, Euler has shown that log. x is involved in the expression of the complete integral: but this appears to be merely a successful assumption; and the rule of integration demonstrated in the present paper admits of no such cases of exception whatever.

The finite solution of linear differential equations may be attempted by resolution of the proposed equation into a system of equations of an inferior order. This method applied to the linear equation under its usual forms leads to the well-known solution of equations with constant coefficients: and when applied to the same equation under the exponential form, it gives a result embracing the solution not only of equations with constant coefficients, but also of a large class of equations with variable coefficients.

The author treats,—1st, of the solution of linear differential equations, total and partial, in series; 2ndly, of their finite integration; 3rdly, of the theory of series, or inverse method of development; 4thly, of linear equations of differences, total and partial, of certain miscellaneous applications, chiefly in the field of definite integrals, single and multiple.

January 25, 1844.

SIR J. W. LUBBOCK, Bart., V.P., in the Chair.

"A Description of an extensive Series of the Water Battery; with an account of some Experiments made in order to test the relation of electrical and chemical action which takes place before and after completion of the Voltaic Circuit." By John P. Gassiot, Esq., F.R.S.

In a former paper, which was printed in the Philosophical Transactions for 1839, the author described a series of experiments made

with some powerful voltaic batteries, for the purpose of determining the possibility of obtaining a spark before the completion of the circuit. This anticipated effect was not, however, produced. A short time after, Mr. Cross stated that he had succeeded in procuring a spark from a battery of 1626 cells of copper and zinc, acted upon by river water. The author, pursuing his researches, constructed a battery consisting of 3520 pairs of copper and zinc cylinders, each pair being placed in a separate glass vessel, well covered with a coating of lac varnish, and insulated by being placed on slips of glass covered on both sides with a thick coating of lac. The cells were placed on 44 separate oaken boards, also covered with lac varnish, each board carrying 80 cells, and sliding into a wooden frame, where they are further insulated by resting on pieces of thick plate-glass, similarly varnished.

In describing the effects which this apparatus has produced, the author endeavours to draw a distinction between the static and the dynamic effects of the developed electricity, and treats of each separately. The conclusions to which he is led from the series of experiments narrated in this paper, are the following:—

1. The elements constituting the voltaic battery assume polar tension before the circuit is completed, even in a single cell; this polar state being shown to exist by the action exerted on the electroscope being different at each polar extremity of the battery.

2. The tension, so produced, when exalted by a succession of series, is such, that a succession of sparks passes between the polar extremities of the battery before their actual contact.

3. The static effects precede, and are independent of the completion of the voltaic circuit, as well as of any perceptible development of chemical or dynamic action.

4. When the current is established, either by actual contact of the extremities, or merely by their approximation, so as to admit of a succession of sparks, its dynamic effects on the galvanometer are the same in both cases; each spark producing a constant deflection of the needle. It is hence inferred that the current, even when the circuit is closed, may be regarded as a series of discharges of electricity of tension, succeeding each other with infinite rapidity.

5. In a battery, of which the chemical elements have but a feeble mutual affinity, as is the case with the water battery, the tension rises very slowly.

6. In order to produce static effects in the voltaic battery, it is an indispensable requisite that the elements be such as are capable of combining by their chemical affinities: and the higher those affinities are exalted, the smaller is the number of parts composing the series requisite to exhibit the effects of tension. The static effects elicited from a voltaic series, afford, therefore, direct evidence of the first step towards chemical combination, or dynamic action.

The author observes, in conclusion, that the chemical effects, when obtained in most of the experiments he has described in this paper, are very feeble; but are precisely the same in character as those exhibited by the more powerful voltaic combinations; and he thinks

it may fairly be concluded that the rationale of each is the same, and that they differ only in the amount of action.

February 15, 1844.

SIR J. W. LUBBOCK, Bart., V.P., in the Chair.

"Some further Observations and Experiments illustrative of the Cause of the Ascent and continued Motion of the Sap," in continuation of a Paper presented to the Royal Society in November 1842. By G. Rainey, Esq. Communicated by P. M. Roget, M.D., Sec. R.S.

The author here gives an account of some experiments which he has lately made, tending, in his opinion, to corroborate the opinions he advanced in his former paper; namely, that the ascending sap is situated in the intercellular and intervascular spaces of the plant, and that its passage into the cells is effected by the action of endosmose, which the intervening membranes, whether living, or deprived of vitality, exert upon that fluid. He found that portions of many plants, such as *Anthriscus vulgaris*, and the *Lapsana communis*, absorb a much larger quantity of fluid when they are immersed in pure water, than when similarly immersed in a solution of gum-arabic; and that, in the latter case, the remaining portion of the solution is of the same specific gravity as before any part has been absorbed by the plant. By a similar process, the author conceives, the fluid which is derived from the earth, and has passed into the intercellular spaces of the cotyledons, are imbibed by its cells by endosmose; while at the same time a fluid containing sugar is passing, by exosmose, out of these cells into the intercellular and intervascular tissue, and thence into the corresponding tissue of the peduncle and young stem; it there meets with, and is diluted by the water ascending in the same tissue from the roots, and the mixture is afterwards distributed over every part of the plant.

February 22, 1844.

SIR J. W. LUBBOCK, Bart., V.P., in the Chair.

"On the Temperature of the Springs, Wells and Rivers of India and Egypt, and of the Sea and Table Lands within the Tropics; with a few Remarks on M. Boussingault's mode of ascertaining the mean temperature of Equinoctial Regions." By Lieut. Newbold, of the Madras Army, F.R.S.

The author adverts to the deficiency of information which has hitherto existed as to the temperature and chemical composition of the springs and rivers both of India and of Egypt; and also as to their geographical and geological relations. He gives, in the present paper, the details of a great number of observations which he has made on these subjects, and which he thinks may prove a useful contribution to Indian hydrography, as well as afford more exact data for philosophical inquiry. The observations extend, at irregular in-